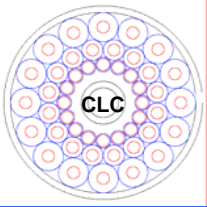


CDF luminosity studies

Roberto Rossin, Sergo Jindariani, Jim Lungu

(many thanks to Aimin Xiao & Tim Bolshakov)

Joint Luminosity Meeting 11/01/05



Outline



Goal:

Look for non linear effects at very high luminosity.

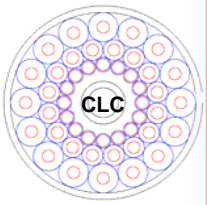
How:

We compare the luminosity measured by CLC with:

- Central Outer Tracker (COT) currents.
- AD calculated luminosity based on beam parameters.

Reminder:

- We previously validated CLC luminosity measurement up to $2.5 \div 3.0 \text{E}32 \text{cm}^{-2} \text{s}^{-1}$. These must be intended as cross checks.



COT currents vs CDF - Idea

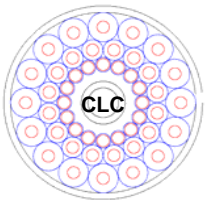


Central Outer Tracker (COT) in CDF is a drift chamber, with 8 superlayers, covering radii between 44cm and 132cm.

If there is no saturation on currents, we expect the currents to scale linearly with luminosity.

We checked the COT currents by comparing SL_i VS SL_j . Only first 2 SLs showed saturation effect (see backup slides if interested).

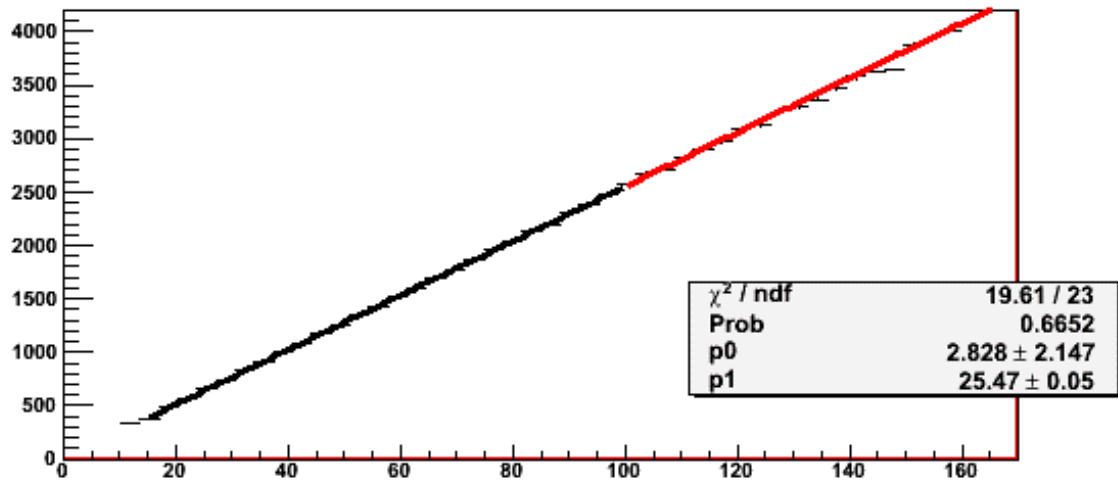
Results we are showing are based on SL_8 . The outermost.



COT currents vs CDF - Results



SuperLayer_8_Cot_vs_Lumi



Here we plot:

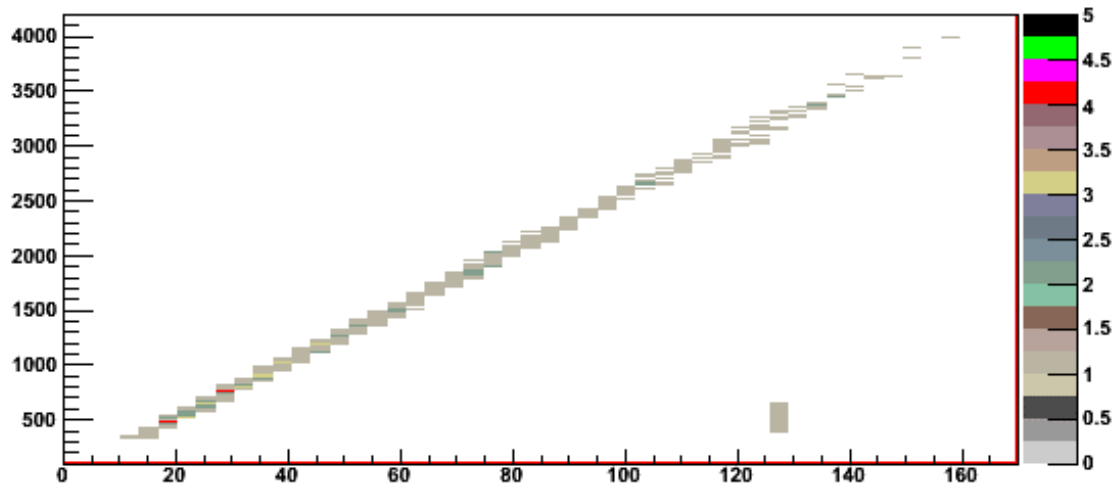
SL8 VS B0lum

X axes \rightarrow Lum[E30cm⁻²s⁻¹]

Y axes \rightarrow SL8 current

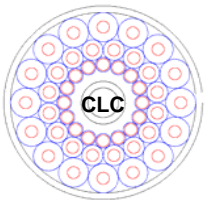
Fit up to 100E30. Extrapolated to guide the eye.

hSuperLayer_8_Cot_vs_Lumi



COT Superlayer 8 is the outermost layer. Less sensitive to current saturation (look at backup slides for checks).

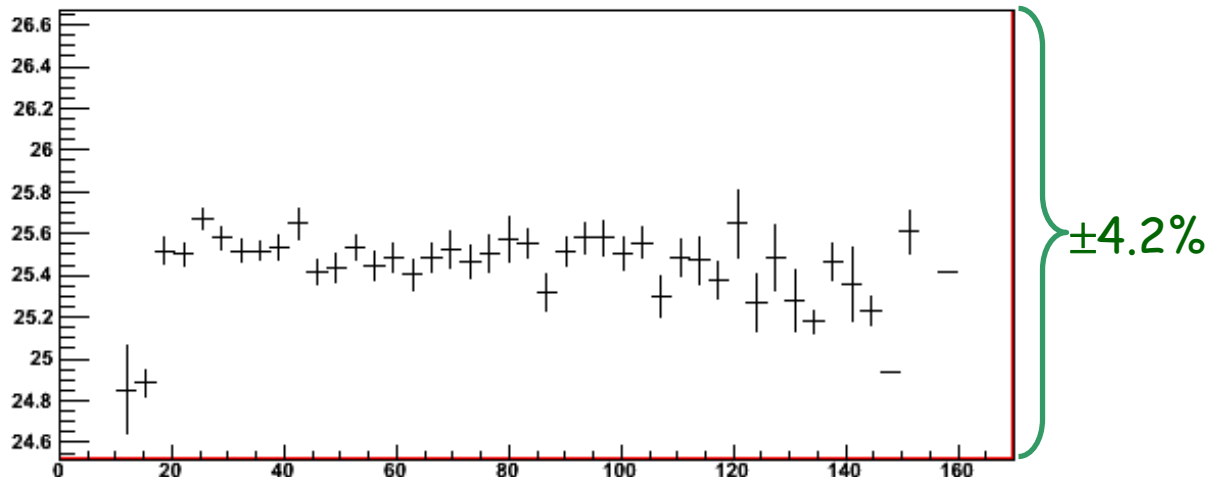
Data collected from Oct 16 to Oct 31 2005



COT currents vs CDF - Results



SuperLayer_8Cot2Lumi_vs_Lumi



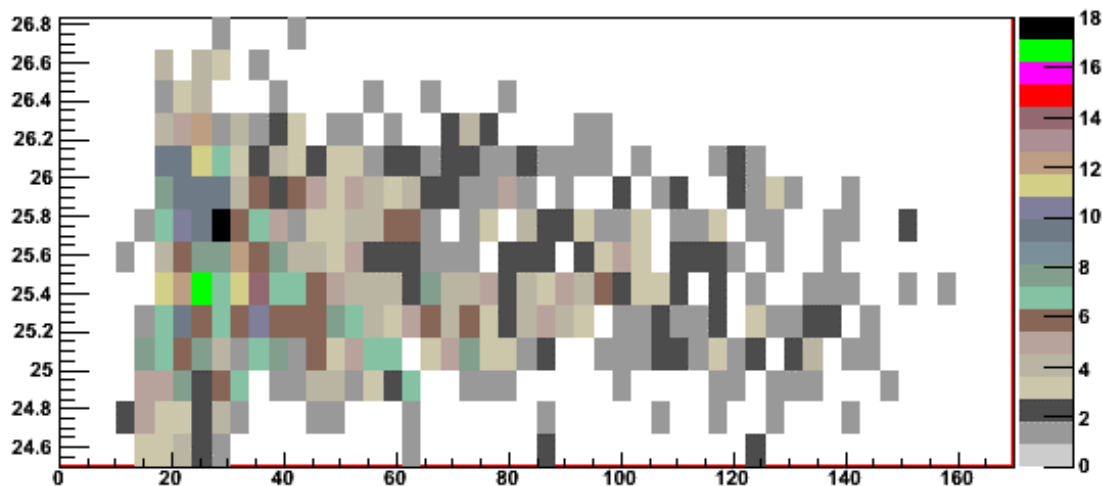
Here we plot:

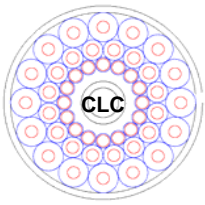
SL8/B0lum VS B0lum

X axes \rightarrow Lum[E30cm⁻²s⁻¹]

Y axes \rightarrow SL8/Lum. Full range is $\pm 4.2\%$, the CDF lum uncertainty.

hSuperLayer_8Cot2Lumi_vs_Lumi





AD vs CDF - Idea



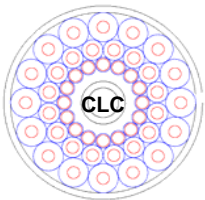
- CDF measures luminosity per every bunch with the CLC
- AD calculate the luminosity per every bunch at IPs by measuring beam parameters and using the formula:

$$L = \frac{6 \cdot 10^{-5} f_{bc} N_p N_a \beta_r \gamma_r}{4\pi\beta^* 0.5 \cdot \sqrt{(\varepsilon_p + \varepsilon_a)_h \cdot (\varepsilon_p + \varepsilon_a)_v}} \cdot H(\sigma_1 / \beta^*)$$

The spread in luminosity among bunches is large (~ 2).

By comparing CDF and AD measurements we can investigate
now $\mu=8 \leftrightarrow L = 2.3E32 \text{ cm}^{-2} \text{ s}^{-1}$ ($L \cdot \sigma = f_{bc} \cdot \mu$)

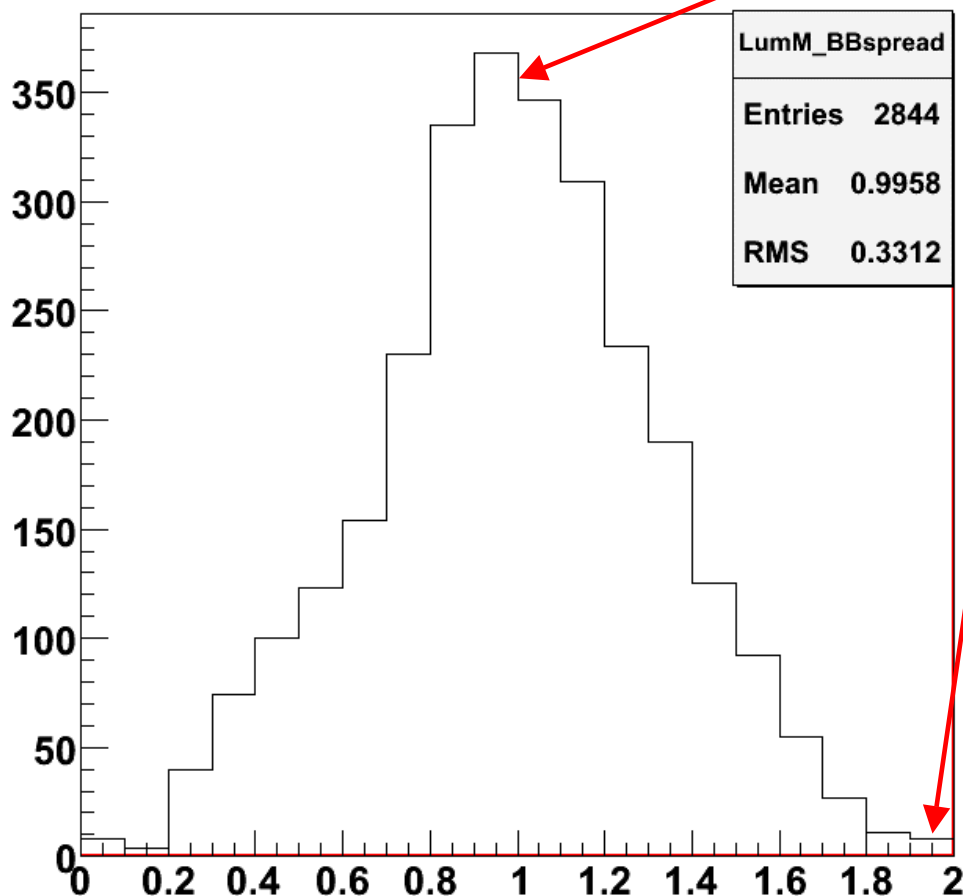
Values measured at the beginning of the stores: Remove halo or HEP1



AD vs CDF - BB luminosity spread



B0 Lum BB spread

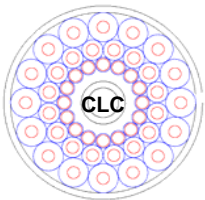


• if $\langle L \rangle_{36} = 1.5E32$

• $L_{\text{maxBunch}} = 3E32$

Single bunch luminosities are spread around the overall luminosity.

Plot shows the bunch by bunch luminosity spread (around average=1) for all bunches.

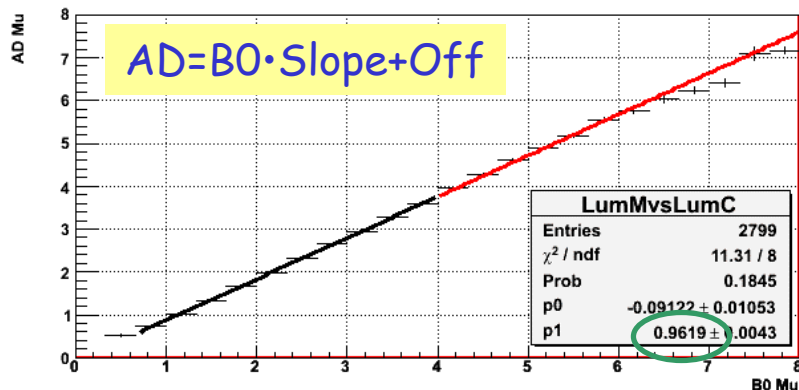


AD vs CDF - Results



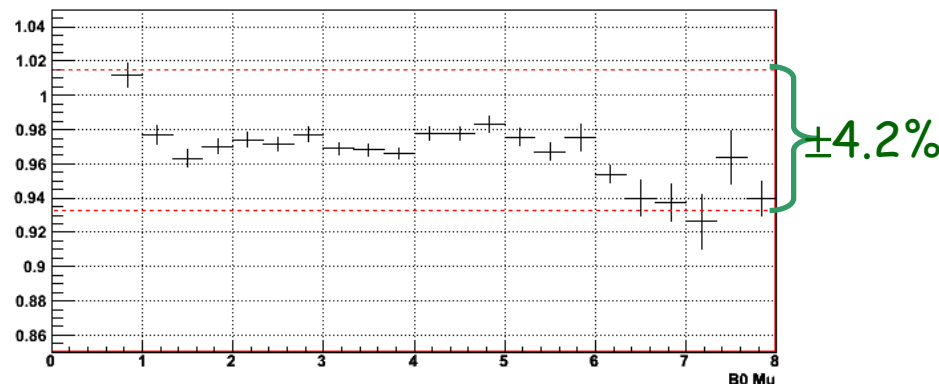
AD vs B0

B0 Meas Lum VS AD Calc Lum

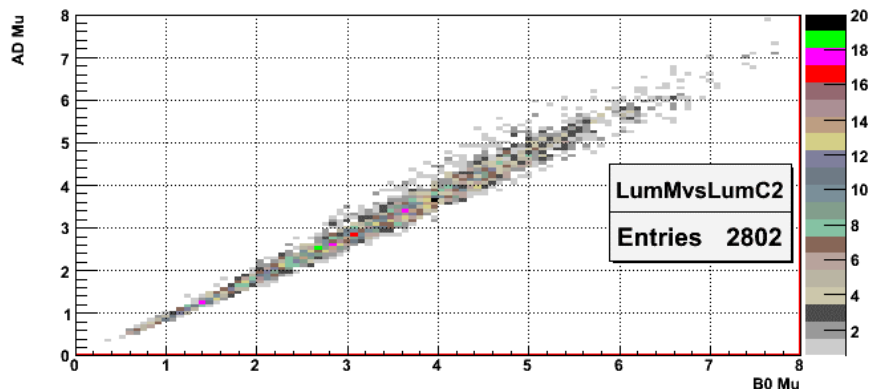


AD-Off/B0 vs B0

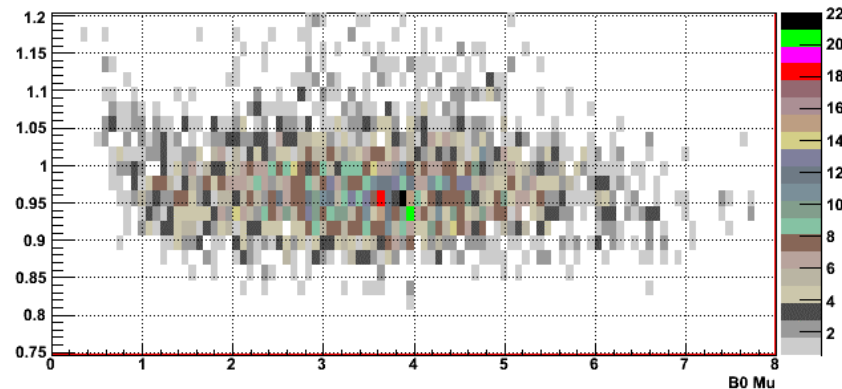
AD over B0 Meas Lum VS B0 mu



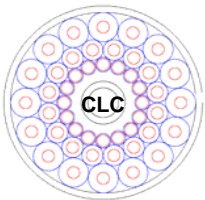
B0 Meas Lum VS AD Calc Lum



AD over B0 Meas Lum VS B0 mu



ADvsCDF Slope = 0.96



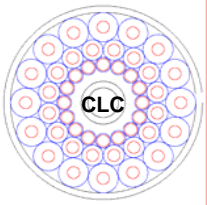
Conclusions



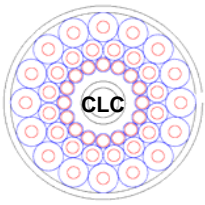
We do **NOT** validate our measurement just looking at COT or AD estimations.

Previous simulation studies showed that the CLC measurement method is valid up to $2.5 \div 3.0 E32 \text{ cm}^{-2} \text{ s}^{-1}$. Still:

- Good linearity dependence between CLC and COT currents.
- Good linearity dependence between CDF and AD luminosity measurements up to $\mu \sim 8 \leftrightarrow L \sim 2.3 E32 \text{ cm}^{-2} \text{ s}^{-1}$
 - Want to check with more data region around $\mu \sim 7 \div 8$
- This performance will improve as soon as we will replace aging PMTs. Planning to do that during shutdown if no emergency occur.
- CLC allows to implement also other measurement methods besides zero counting (currently adopted). We are investigating new approaches to be ready for even higher luminosities.
- We monitor closely the behaviour of the CLC.



BACKUP SLIDES



Backup: COT current saturation checks



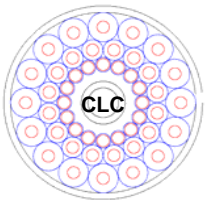
SuperLayer_	1	_VS_	2	:	p0:	12.08	p1:	1.134	p2:	1.04E-06
SuperLayer_	1	_VS_	3	:	p0:	15.355	p1:	0.755	p2:	4.33E-06
SuperLayer_	2	_VS_	3	:	p0:	23.327	p1:	0.656	p2:	3.72E-06
SuperLayer_	1	_VS_	4	:	p0:	18.907	p1:	0.835	p2:	5.45E-06
SuperLayer_	2	_VS_	4	:	p0:	28.865	p1:	0.725	p2:	4.77E-06
SuperLayer_	3	_VS_	4	:	p0:	8.082	p1:	1.105	p2:	1.83E-07
SuperLayer_	1	_VS_	5	:	p0:	19.038	p1:	0.756	p2:	6.04E-06
SuperLayer_	2	_VS_	5	:	p0:	28.065	p1:	0.656	p2:	5.17E-06
SuperLayer_	3	_VS_	5	:	p0:	10.222	p1:	0.998	p2:	2.22E-06
SuperLayer_	4	_VS_	5	:	p0:	26.865	p1:	0.888	p2:	3.24E-06
SuperLayer_	1	_VS_	6	:	p0:	17.219	p1:	0.649	p2:	5.45E-06
SuperLayer_	2	_VS_	6	:	p0:	24.466	p1:	0.564	p2:	4.58E-06
SuperLayer_	3	_VS_	6	:	p0:	7.32	p1:	0.86	p2:	1.68E-06
SuperLayer_	4	_VS_	6	:	p0:	22.116	p1:	0.764	p2:	2.71E-06
SuperLayer_	5	_VS_	6	:	p0:	13.84	p1:	0.846	p2:	1.97E-06
SuperLayer_	1	_VS_	7	:	p0:	14.601	p1:	0.564	p2:	5.30E-06
SuperLayer_	2	_VS_	7	:	p0:	19.233	p1:	0.491	p2:	4.22E-06
SuperLayer_	3	_VS_	7	:	p0:	4.348	p1:	0.749	p2:	1.99E-06
SuperLayer_	4	_VS_	7	:	p0:	17.067	p1:	0.666	p2:	2.77E-06
SuperLayer_	5	_VS_	7	:	p0:	9.908	p1:	0.737	p2:	2.19E-06
SuperLayer_	6	_VS_	7	:	p0:	4.754	p1:	0.858	p2:	3.40E-06
SuperLayer_	1	_VS_	8	:	p0:	12.743	p1:	0.493	p2:	4.13E-06
SuperLayer_	2	_VS_	8	:	p0:	18.701	p1:	0.428	p2:	3.54E-06
SuperLayer_	3	_VS_	8	:	p0:	3.856	p1:	0.655	p2:	8.79E-07
SuperLayer_	4	_VS_	8	:	p0:	15.587	p1:	0.582	p2:	1.85E-06
SuperLayer_	5	_VS_	8	:	p0:	10.323	p1:	0.643	p2:	1.52E-06
SuperLayer_	6	_VS_	8	:	p0:	5.509	p1:	0.749	p2:	1.39E-06
SuperLayer_	7	_VS_	8	:	p0:	-0.938	p1:	0.865	p2:	8.71E-07

• Fit $SL(j)$ VS $SL(i)$ currents with quadratic function.

$$f = p0 + p1 \cdot x + p2 \cdot x^2$$

• COT current saturation observed only on first 2 layers. Quadratic term different from 0. (stat error on $p2 \sim 1E-06$)

• Outer SLs do not show this problem



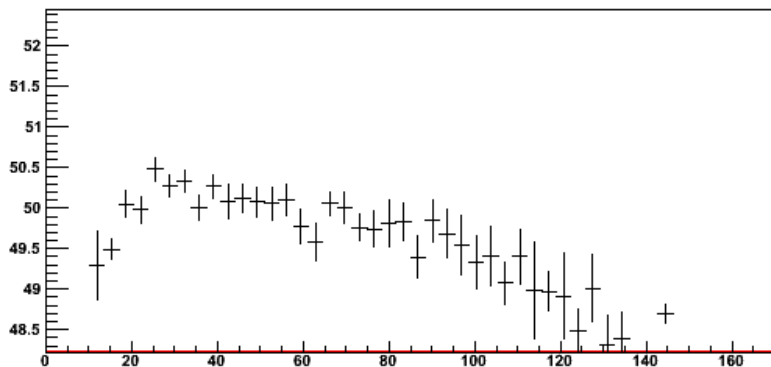
Backup: COT current saturation checks



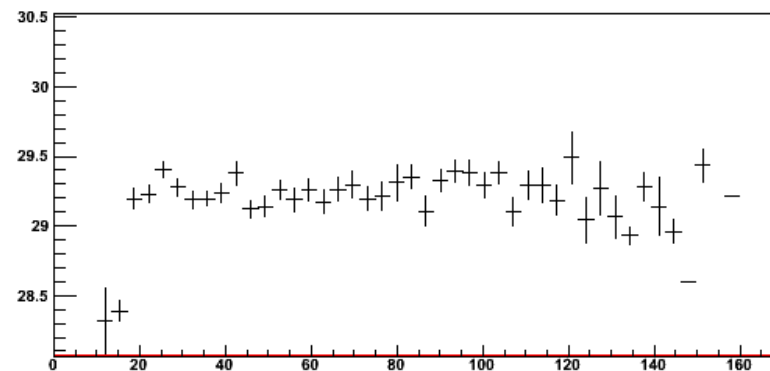
• SL1 ... bad

SL7 ... good too

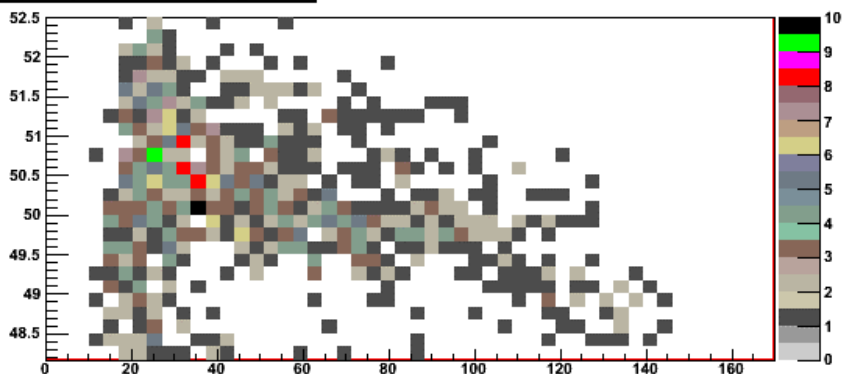
SuperLayer_1Cot2Lumi_vs_Lumi



SuperLayer_7Cot2Lumi_vs_Lumi



hSuperLayer_1Cot2Lumi_vs_Lumi



hSuperLayer_7Cot2Lumi_vs_Lumi

